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Deuterons or Tritons for Muon Collider Driver

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The present scenario [1] for the $\mu\mu$-Collider calls for protons to be accelerated in a 'driver' to somewhere in the 8–30 GeV range. Upon interaction in a target these protons produce—among other particles—pions and kaons which subsequently decay into the desired muons. This note briefly examines possible gains which may be realized by using either deuterons or tritons as projectiles in the driver. Particles with multiple charge are not considered here. Although they should not be summarily dismissed, at least two types of difficulties are exacerbated by higher Z projectiles: space charge in the machine and energy deposited directly by the beam particles in the target ($dE/dx \propto Z^2$). The latter is often associated with the maximum energy deposition density in the target and thus critical when considering target integrity. It should be noted that tritium is not as readily available as either hydrogen or deuterium and is a low energy β^- emitter (E_{max}=0.0187 MeV) with a 12.3 year half-life. But none of this appears to be a serious obstacle to its use in the driver.

To roughly quantify the benefits of the heavier projectiles their pion yields are calculated assuming that pion production—at constant momentum per nucleon—is proportional to nucleon number. This should really be modified to include effects such as stripping and shadowing as well as for differences in pion production between neutrons and protons. In a *thick target* these are likely to have only minor consequences and it is not clear *a priori* whether yields are positively or negatively affected by them. One plausible benefit: since protons tend to produce more π^+ than π^-, using deuterons and tritons may improve their balance. Kaons are ignored since they con-

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of energy deposition profiles with those for protons in both the target and its surroundings also would be useful. Since total energy incident on the target is about the same, large differences are not expected. The Fermi motion of the nucleons in a deuteron or triton may cause the phase space of the produced pions to be somewhat larger although some or all of this will be offset by the smaller average p_T of pions produced at 10 *vs* 30 GeV/c. All of this best awaits simulation with a refined nuclear collision model. Such a model should include some detail about stripping, etc., formulated specifically for deuterons and tritons with their relatively loose nuclear binding. Experimental checks of key model ingredients and predictions should be performed. Because of the stripping—which leaves the 'spectator' nucleon(s) free to interact downstream—thick target experiments would provide the most convincing validation. For now the preliminary conclusion is that a gain of up to a factor of two in yield—four in luminosity—appears feasible with tritons. This makes further investigation worthwhile.

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References

[1] R. Palmer et al., *Muon Collider Design*, BNL-62949 (1996).

[2] N. V. Mokhov, R. J. Noble, and A. Van Ginneken, *Target and Collection Optimization for Muon Colliders*, Proc. 9th Adv. ICFA Beam Dynamics Workshop, Ed. J. C. Gallardo, AIP Press, to be published.

[3] see Chapter 4 in *$\mu^+\mu^-$-Collider: A Feasibility Study*, Ed. J. C. Gallardo, Fermilab-Conf.-96/092 (1996).

[4] N. V. Mokhov, *The* MARS *Code System User's Guide, version 13 (95)*, FNAL-FN-628 (1995).

[5] see Chapter 5 of ref. [3].